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1.	Your reference	PHB 34314
2.	Patent application number *(The Patent Office will fill in this part)*	16 JAN 1999 **9900910.2**
3.	Full name, address and postcode of the or of each applicant *(underline all surnames)*	KONINKLIJKE PHILIPS ELECTRONICS N.V. GROENEWOUDSEWEG 1 5621 BA EINDHOVEN THE NETHERLANDS
	Patents ADP Number *(if you know it)*	06828487001
	If the applicant is a corporate body, give the country/state of its incorporation	THE NETHERLANDS 7419294001
4.	Title of the invention	RADIO COMMUNICATION SYSTEM
5.	Name of your agent *(if you have one)*	COLIN JAMES MOODY
	"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*	Philips Electronics Patents & Trade Marks Department Cross Oak Lane Redhill Surrey RH1 5HA
	Patents ADP number *(if you know it)*	7133051001
6.	If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number	Country / Priority Application number / Date of filing
7.	If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application	Number of earlier application / Date of filing *(day/month/year)*
8.	Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer "Yes" if:* *a) any applicant named in part 3 is not an inventor, or* *b) there is an inventor who is not named as an applicant, or* *c) any named applicant is a corporate body.* *See note (d))*	YES

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Continuation sheets of this form	
Description	7x2
Claims(s)	3x2
Abstract	1x2
Drawings	2x2

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Translations of priority documents

Statement of inventorship and right to grant of a patent (*Patents Form 7/77*)

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11. I/We request the grant of a patent on the basis of this application.

Signature C J Moody Date 14 January 1999

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DESCRIPTION

RADIO COMMUNICATION SYSTEM

The present invention relates to a radio communication system and further relates to primary and secondary stations for use in such a system and to a method of operating such a system. While the present specification describes a system with particular reference to the emerging Universal Mobile Telecommunication System (UMTS), it is to be understood that such techniques are equally applicable to use in other mobile radio systems.

There are two basic types of communication required between a Base Station (BS) and a Mobile Station (MS) in a radio communication system. The first is user traffic, for example speech or packet data. The second is control information, required to set and monitor various parameters of the transmission channel to enable the BS and MS to exchange the required user traffic.

In many communication systems one of the functions of the control information is to enable power control. Power control of signals transmitted to the BS from a MS is required so that the BS receives signals from different MS at approximately the same power level, while minimising the transmission power required by each MS. Power control of signals transmitted by the BS to a MS is required so that the MS receives signals from the BS with a low error rate while minimising transmission power, to reduce interference with other cells and radio systems. In a two-way radio communication system power control is normally operated in a closed loop manner, whereby the MS determines the required changes in the power of transmissions from the BS and signals these changes to the BS, and vice versa.

An example of a combined time and frequency division multiple access system employing power control is the Global System for Mobile communication (GSM), where the transmission power of both BS and MS transmitters is controlled in steps of 2dB. Similarly, implementation of power

control in a system employing spread spectrum Code Division Multiple Access (CDMA) techniques is disclosed in US-A-5 056 109.

A problem with these known techniques is that at the start of a transmission the power control loops may take some time to converge satisfactorily, since the initial power levels are derived from open loop measurements which may not be sufficiently accurate as the channels on which they were made are likely to have different characteristics from the newly initiated channels.

An object of the present invention is to alleviate the above problem.

According to a first aspect of the present invention there is provided a radio communication system comprising a primary station and a plurality of secondary stations, the system having a frequency division duplex communication channel between the primary station and a secondary station, the channel comprising an uplink and a downlink control channel for transmission of power control and bit rate information, and a data channel for the transmission of data packets, and the primary and secondary stations having power control means for adjusting the power of the control and data channels in a series of steps, characterised in that the size of the power control steps can be varied.

According to a second aspect of the present invention there is provided a radio communication system comprising a primary station and a plurality of secondary stations, the system having a frequency division duplex communication channel between the primary station and a secondary station, the channel comprising an uplink and a downlink control channel for transmission of power control and bit rate information, and a data channel for the transmission of data packets, characterised in that the primary and secondary stations have means for delaying the initial transmission of the data channel until after initial transmission of the control channels.

According to a third aspect of the present invention there is provided a primary station for use in a radio communication system made in accordance with the present invention.

According to a fourth aspect of the present invention there is provided a secondary station for use in a radio communication system made in accordance with the present invention.

According to a fifth aspect of the present invention there is provided a method of operating a radio communication system made in accordance with the present invention, characterised by varying the size of the power control steps.

According to a sixth aspect of the present invention there is provided a method of operating a radio communication system made in accordance with the present invention, characterised by delaying the initial transmission of the data channel until after the initial transmission of the control channels.

Embodiments of the present invention will now be described, by way of example, with reference to the accompanying drawings, wherein:

Figure 1 is a block schematic diagram of a radio communication system;

Figure 2 illustrates a conventional scheme for establishing a communication link;

Figure 3 illustrates a scheme in accordance with the present invention for establishing a communication link, having a delayed start to data transmission; and

Figure 4 is a flow chart illustrating a method in accordance with the present invention for performing power control operations having a variable step size.

In the drawings the same reference numerals have been used to indicate corresponding features.

Referring to Figure 1, a radio communication system which can operate in a frequency division duplex mode comprises a primary station (BS) 100 and a plurality of secondary stations (MS) 110. The BS 100 comprises a microcontroller (μC) 102, transceiver means (Tx/Rx) 104 connected to radio transmission means 106, power control means (PC) 107 for altering the

transmitted power level, and connection means 108 for connection to the PSTN or other suitable network. Each MS 110 comprises a microcontroller (μC) 112, transceiver means (Tx/Rx) 114 connected to radio transmission means 116, and power control means (PC) 118 for altering the transmitted power level. Communication from BS 100 to MS 110 takes place on a downlink frequency channel 122, while communication from MS 110 to BS 100 takes place on an uplink frequency channel 124.

One UMTS embodiment uses the scheme of Figure 2 for establishing a communication link between MS 110 and BS 100. The link is initiated by the MS 110 transmitting a request 202 (REQ) for resources on the uplink channel 124. If it receives the request and has available resources, the BS 100 transmits an acknowledgement 204 (ACK) on the downlink channel 122 providing the necessary information for communication to be established. After the acknowledgement 204 has been sent, two control channels (CON) are established, an uplink control channel 206 and a downlink control channel 208, and an uplink data channel 210 is established for transmission of data from the MS 110 to the BS 100.

In this scheme separate power control loops operate in both uplink 124 and downlink 122 channels, each comprising an inner and an outer loop. The inner loop adjusts the received power to match a target power, while the outer loop adjusts the target power to the minimum level that will maintain the required quality of service (i.e. bit error rate). However, this scheme has the problem that when transmissions start on the control channels 206, 208 and data channel 210 the initial power levels and quality target are derived from open loop measurements, which may not be sufficiently accurate as the channels on which the measurements were made are likely to have different characteristics from the newly initiated channels. The result of this is that data transmissions at the start of the data channel 210 are likely to be received in a corrupted state.

One known partial solution to this problem is for the BS 100 to measure the received power level of the request 202 and to instruct the MS 110, within the acknowledgement 204, an appropriate power level for the uplink data

transmission 210. This improves matters, but there may still be errors introduced by the temporal separation between the request 202 and the start of the uplink data transmission 210.

Figure 3 illustrates a solution to the problem in accordance with the present invention, in which the start of the uplink data transmission 210 is delayed by a time 302 sufficient for the power control to have converged sufficiently to enable satisfactory reception of data transmissions by the BS 100. A delay of one or two frames (10 or 20ms) is likely to be sufficient, although longer delays 302 may be permitted if necessary. The additional overhead in the transmission of extra control information on the control channels 206, 208 is balanced by a reduced Eb/No (energy per bit / noise density) for the user data received by the BS 100 over the data channel 210.

The delay 302 could be predetermined or it could be determined dynamically, either by the MS 110 (which could detect convergence by monitoring downlink power control information) or the BS 100.

Figure 4 is a flow chart showing another solution to the problem in accordance with the present invention, in which the power control step size is variable. Since the power control error is likely to be greatest at the start of a transmission, the optimum power control step will be larger than that used for normal operation.

The method starts 402 with the beginning of the transmissions of the control channels 206, 208 and the data channel 210. The difference between the received power and target power is then determined at 404. Next the power control step is tested at 406 to determine whether it is greater than the minimum. If it is the power control step is adjusted at 408 before adjustment of the power at 410. The change in step size could be deterministic, or based on previous power control adjustments or on some quality measurement. The power control loop then repeats, starting at 404.

When using the method, it is preferred to set the power control step initially to a large value, then reduce it progressively until it reaches the value set for normal operation (which may be cell or application specific). Preferably the ratio between successive steps is less than two, to allow for the possibility

of correcting errors in transmission or due to other factors. The power control step could be changed in both uplink 124 and downlink 122 channels.

As an example, consider an initial sequence of power control steps (in dB) of: 3.0, 2.0, 1.5, 1.0, 0.75, 0.75, 0.5, 0.5, 0.25, where 0.25dB is the minimum step. Using this sequence with power control signals every 1ms, an initial error of up to 10dB could be corrected within half a frame (5ms), compared with 2.5 frames using the minimum power control step of 0.25dB that is normally used. Although as described here the steps are symmetric (i.e. the same steps are applicable to increases or decreases in power), it is known (for example from US-A-5 056 109) that this is not always appropriate.

The selection of initial step size and the rate of change could be predetermined, or determined dynamically. For example, if the power level adjustment signalled in the acknowledgement 204 is large then the initial step size could be increased. As another example, if the MS 110 is able to determine by other means that it has a high speed relative to the BS 100 a larger step is likely to be appropriate.

Combinations of the techniques described above can readily be used to provide improved results.

Although the description above has examined data transmission on the uplink channel 124, the techniques are equally applicable to data transmission on the downlink channel 122 or to bidirectional transmissions.

Embodiments of the present invention have been described using spread spectrum Code Division Multiple Access (CDMA) techniques, as used for example in UMTS embodiments. However, it should be understood that the invention is not limited to use in CDMA systems.

From reading the present disclosure, other modifications will be apparent to persons skilled in the art. Such modifications may involve other features which are already known in radio communication systems and component parts thereof, and which may be used instead of or in addition to features already described herein. Although claims have been formulated in this application to particular combinations of features, it should be understood that the scope of the disclosure of the present application also includes any

novel feature or any novel combination of features disclosed herein either explicitly or implicitly or any generalisation thereof, whether or not it relates to the same invention as presently claimed in any claim and whether or not it mitigates any or all of the same technical problems as does the present invention. The applicants hereby give notice that new claims may be formulated to such features and/or combinations of features during the prosecution of the present application or of any further application derived therefrom.

CLAIMS

1. A radio communication system comprising a primary station and a plurality of secondary stations, the system having a frequency division duplex communication channel between the primary station and a secondary station, the channel comprising an uplink and a downlink control channel for transmission of power control and bit rate information, and a data channel for the transmission of data packets, and the primary and secondary stations having power control means for adjusting the power of the control and data channels in a series of steps, characterised in that the size of the power control steps can be varied.

2. A system as claimed in claim 1, characterised in that the primary and secondary stations comprise signal power measuring means and in that the power control means adjusts the size of the power control steps in response to the measured signal power.

3. A system as claimed in claim 1 or 2, characterised in that the primary and secondary stations comprise means for storing predetermined sequences of power control steps and in that means are provided for selecting one of said predetermined sequences.

4. A system as claimed in any one of claims 1 to 3, characterised in that the selected power control step depends on the required power level adjustment.

5. A radio communication system comprising a primary station and a plurality of secondary stations, the system having a frequency division duplex communication channel between the primary station and a secondary station, the channel comprising an uplink and a downlink control channel for

transmission of power control and bit rate information, and a data channel for the transmission of data packets, characterised in that the primary and secondary stations have means for delaying the initial transmission of the data channel until after initial transmission of the control channels.

6. A system as claimed in claim 5, characterised in that the delay in transmission of the data channels is sufficient to enable the power control means to have substantially corrected the difference between initial and target power levels in the control channels.

7. A system as claimed in claim 5 or 6, characterised in that the delay in transmission of the data channels is predetermined.

8. A system as claimed in claim 5 or 6, characterised in that the delay in transmission of the data channels is determined dynamically.

9. A system as claimed in any one of claims 5 to 8, characterised in that the primary and secondary stations comprise power control means for adjusting the power of the control and data channels in a series of steps towards a target power.

10. A primary station for use in a radio communication system as claimed in any one of claims 1 to 9.

11. A secondary station for use in a radio communication system as claimed in any one of claims 1 to 9.

12. A method of operating a radio communication system as claimed in any one of claims 1 to 4, characterised by varying the size of the power control steps.

13. A method of operating a radio communication system as claimed in any one of claims 5 to 9, characterised by delaying the initial transmission of the data channel until after the initial transmission of the control channels.

14. A radio communication system substantially as hereinbefore described with reference to and as shown in the accompanying drawings.

15. A primary station for use in a radio communication system substantially as hereinbefore described with reference to and as shown in the accompanying drawings.

16. A secondary station for use in a radio communication system substantially as hereinbefore described with reference to and as shown in the accompanying drawings.

17. A method of operating a radio communication system substantially as hereinbefore described with reference to and as shown in the accompanying drawings.

ABSTRACT

RADIO COMMUNICATION SYSTEM

A radio communication system has means for ensuring that power control of a frequency division duplex channel has been established for the transmission of data. In one embodiment the transmission of a data channel can be delayed until adequate power control has been established. In another embodiment power control can be applied in steps of varying size. In a further embodiment the transmission of a data channel can be delayed until adequate power control has been established by changing power in a sequence of steps of varying size. These techniques overcome the problem that data transmissions at the start of a data channel are likely to be corrupted because of incorrect power levels.

(Figure 4)

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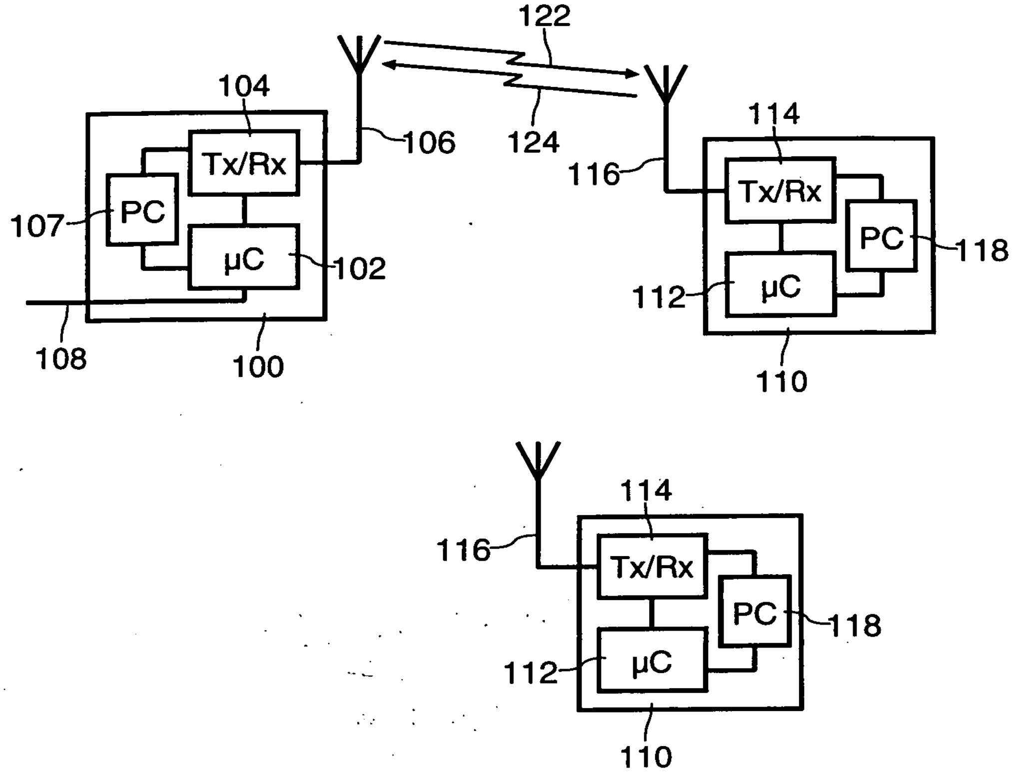
122
124
104
Tx/Rx
106
PC
107
μC
102
108
100
114
Tx/Rx
116
PC
118
μC
112
110
114
Tx/Rx
116
PC
118
μC
112
110

FIG. 1

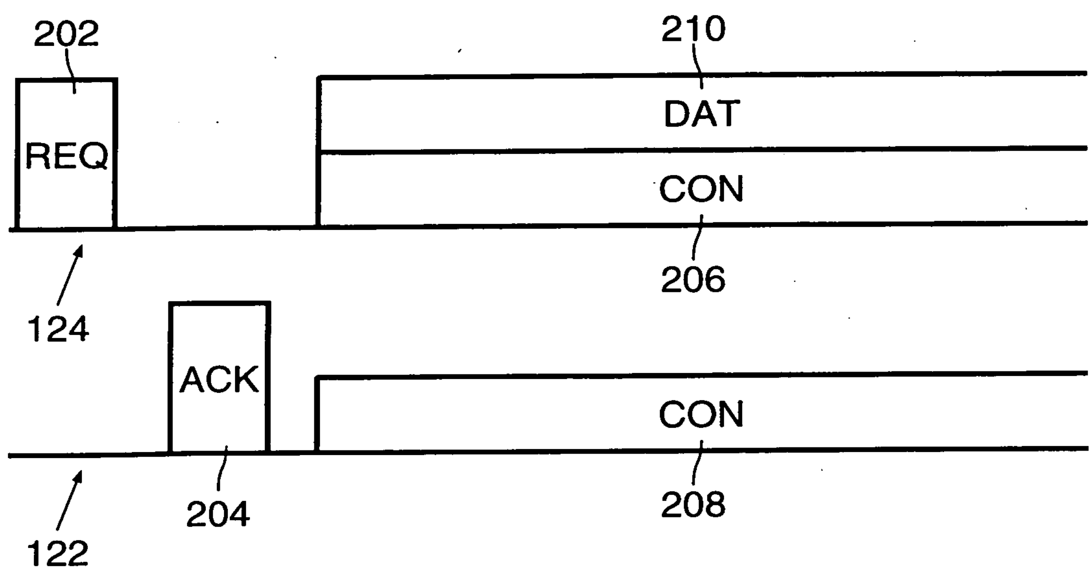
202
REQ
210
DAT
CON
206
124
ACK
CON
204
208
122

FIG. 2

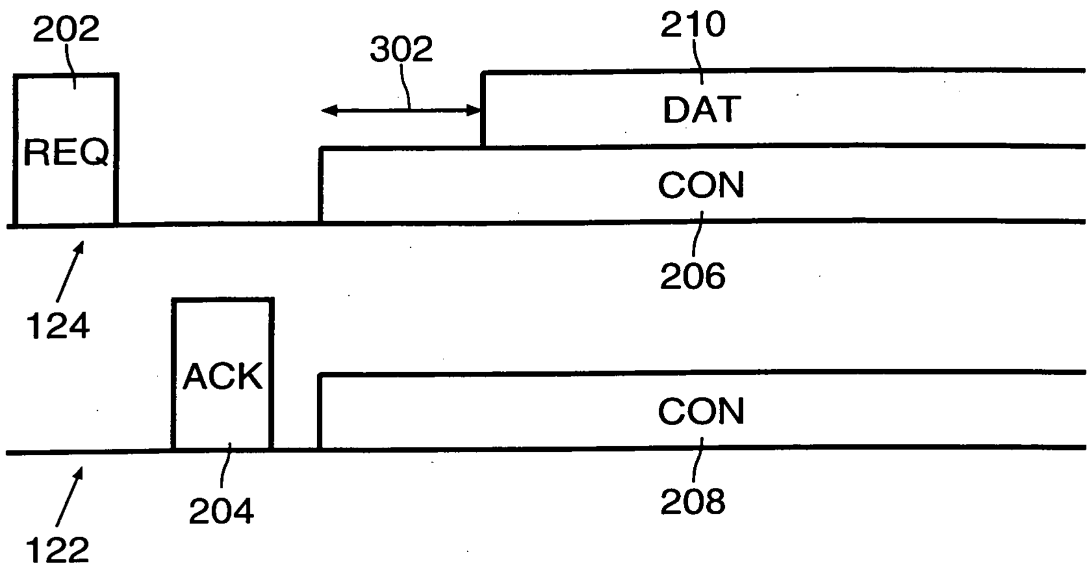
202
302
210
REQ
DAT
CON
124
206
ACK
CON
122
204
208

FIG. 3

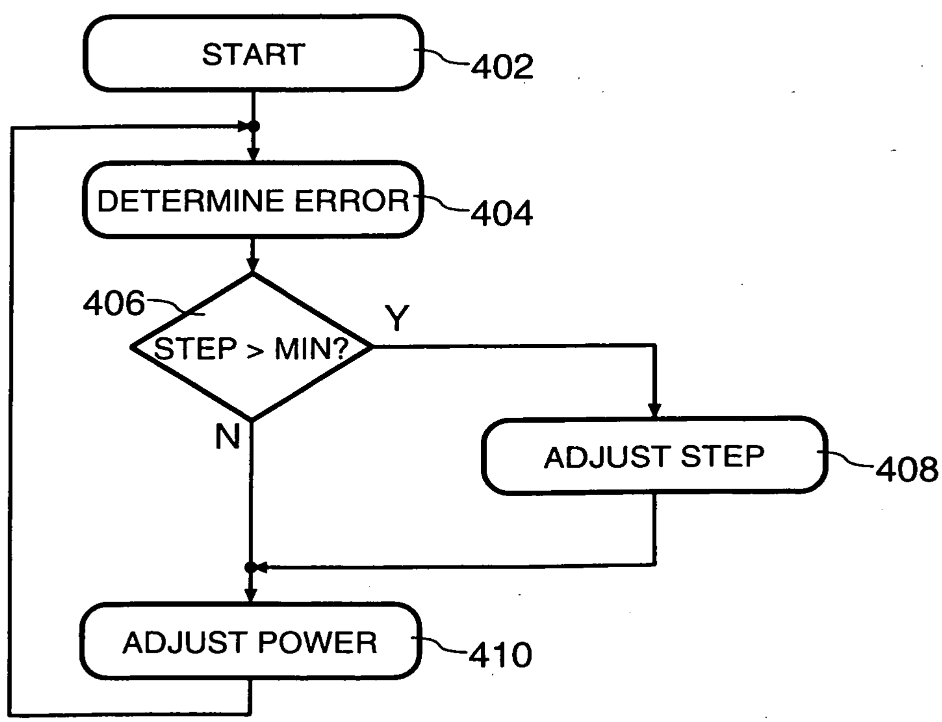
START
402
DETERMINE ERROR
404
406
STEP > MIN?
Y
N
ADJUST STEP
408
ADJUST POWER
410

FIG. 4